Hancock Brook

Plymouth, Connecticut

Hancock Brook Lake Dam-Break Flood Analysis

September 1985

US Army Corps of Engineers
New England Division

HANCOCK BROOK LAKE
HOUSATONIC RIVER BASIN
CONNECTICUT

DAM-BREAK FLOOD ANALYSIS

BY
HYDROLOGIC ENGINEERING SECTION
WATER CONTROL BRANCH
ENGINEERING DIVISION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

SEPTEMBER 1985

DAM-BREAK FLOOD ANALYSIS
HANCOCK BROOK LAKE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

HANCOCK BROOK LAKE
DAM-BREAK FLOOD ANALYSIS

1. PURPOSE

This report presents the findings of a dam-break flood analysis performed for Hancock Brook Lake. The dam, is located on Hancock Brook in the town of Plymouth, Connecticut, approximately 3.2 miles upstream of its confluence with the Naugatuck River. Location of the dam is shown on plates 1, 2 and 9.

Included in the report are sections describing pertinent features of the dam, procedures used for the analysis, assumed dam-break conditions, and effects of varying conditions (sensitivity tests) on the resulting downstream flood, discharges and stages. This study was not performed due to any known likelihood of a dam-break at Hancock Brook Lake. Its only purpose was to provide quantitative information for emergency planning use in accordance with ER 1130-2-419.

2. PROCEDURE

The Hancock Brook dam-break analysis was made using the "National Weather Service Dam-Break Flood Forecasting Computer Model", developed by D. L. Fread, Research Hydrologist, Office of Hydrology, National Weather Service, NOAA, Silver Spring, Maryland 20910. Input to the computer model consisted of: (a) storage characteristics of the reservoir, (b) selected geometry and timing of the dam-break and (c) hydraulic characteristics of the downstream river channel including tributary inflows, roughness coefficients, contraction-expansion loss coefficients, and active and inactive flow regions. Based on input data, the program simulates a prebreach high flow steady state condition, then computes the dam-break outflow hydrograph and routes it downstream. Calibration of the model is accomplished by comparing model computed prebreach stage-discharge relations with known stage-discharge relations at various index locations along the river (i.e., at dams, gages, etc.). The dynamic unsteady flow routing is performed by a "honing" iterative process governed by requirements of both the principle of conservation of mass and the principle of conservation of momentum. The analysis provides output on the attenuation of the flood hydrograph, resulting flood stages, and the timing of the flood wave as it progresses downstream. The dam-break analysis for Hancock Brook Dam was performed in two steps: (a) the supercritical dynamic method (IOPT option 3) was used for one reach, the steep 2.2 miles of river reach just downstream of Hancock Brook Dam and (b) the subcritical dynamic method (IOPT option 9) was used for the remaining four reaches, a distance of 15.7 miles. A listing of the computer input data used for the base flood is shown on plates 15 and 16.

3. DESCRIPTION

a. General. The study extended from Hancock Brook Lake in Plymouth, Connecticut downstream along Hancock Brook to its confluence with the Naugatuck River in Waterbury, Connecticut, and continued along the Naugatuck to Beacon Falls, Connecticut, for a total distance of about 18 miles. The drainage area contributing to the study reach increases from 12-square miles at Hancock Brook Lake to 261-square miles at Beacon Falls. The major tributaries in the study reach are Steel Brook, Mad River, and Hop Brook. There are six other Corps of Engineer flood control reservoirs in the Naugatuck River watershed above Beacon Falls, which are operated as a system to reduce flooding throughout the length of the Naugatuck River. Location of the flood control reservoirs is shown on plate 2.

b. Hancock Brook Lake. Hancock Brook Lake is primarily a flood control reservoir with some water-based recreational activities. The project is self regulating and stores excessive Hancock Brook floodwaters. The project was built by the Corps of Engineers and placed in operation in August 1966. Hancock Brook Lake is maintained by the Corps and is one of seven Corps reservoir projects operated to reduce downstream flood stages along the Naugatuck River. A map of the Housatonic River basin is shown on plate 1. A map of the Naugatuck River watershed, with existing Corps projects indicated, is shown on plate 2.

Hancock Brook dam is a rolled earth fill embankment, with rock slope protection, 630 feet in length and a maximum height of 57 feet above the streambed. A photograph of the dam is shown on plate 4 and a general plan is shown on plate 5. The spillway, shown on plate 7, is located adjacent to the right abutment of the dam and is an uncontrolled chute type, 100 feet long with a crest elevation of 484 feet NGVD. The outlet works are located on the right bank and consist of an inlet channel, a U-shaped concrete weir to control the permanent pool, a 3'0" by 4'6" high rectangular conduit 250 feet in length, and an outlet channel. A plan and profile of the outlet works is shown on plate 6. The lake contains a flood control storage capacity, at spillway crest, of 3,900 acre-feet equivalent to 6.13 inches of runoff from the 12.0 square mile drainage area. Pertinent data on Hancock Brook Lake is listed in table I.

TABLE I

HANCOCK BROOK LAKE
PERTINENT DATA

LOCATION	Hancock Brook, Plymouth, Connecticut
DRAINAGE AREA	12 Square Miles
STORAGE USE	Flood Control, Conservation

RESERVOIR STORAGE

Inlet Elevation	454 feet NGVD
Conservation Pool	460 feet NGVD
Maximum Surcharge	499.7 feet NGVD
Top of Dam	505 feet NGVD

EMBANKMENT

Type	Rolled earth fill, rock slope protection, impervious core.
Length	630 feet
Top Width	20 feet
Top Elevation	505 feet NGVD
Maximum Height	57 feet

SPILLWAY

Location	West Abutment
Type	Uncontrolled, ogee weir, chute
Crest Length	100 feet
Crest Elevation	484 feet NGVD
Surcharge	15.7 feet
Capacity	16,600 cfs

OUTLET CONDUIT

Type	Rectangular concrete, conduit
Tunnel Size	3 feet by 4.5 feet
Tunnel Length	250 feet
Service Gate Type	Ungated
Discharge Capacity	
Spillway Crest	377 cfs
Downstream Channel	
Capacity	350 cfs

c. <u>Downstream Valley</u>. The river channel within the study reach downstream of Hancock Brook Lake, flows through four central Connecticut communities: Watertown, Waterbury, Naugatuck, and Beacon Falls in downstream order. Cross sectional data required for the model within this study reach was obtained from USGS topographical maps and flood plain mapping as well as available survey information.

Hancock Brook is relatively steep, falling about 180 feet in about 3.1 miles from Hancock Brook Dam to the confluence with the Naugatuck River for an average gradient of about 58 feet per mile. The Naugatuck River has a lesser slope and falls uniformly about 180 feet in 14.9 miles from the mouth of Hancock Brook to downstream of the USGS gage in Beacon Falls for an average gradient of about 12 feet per mile. The flood plain reaches a maximum width of about 3,000 feet in Waterbury.

There are 26 bridges crossing over Hancock Brook and the Naugatuck River within the study reach including one crossing of a limited access type highway, 5 state highways, 4 railroads, and 16 local roads. In addition, there are five dams throughout the study reach. Five dams within the study reach are described below. Principal tributaries in the study reach are Steel and Hop Brooks, and Mad River.

(1) <u>Dam 2.2 Miles Downstream of Hancock Brook Dam</u>. This dam is located in Waterbury about 2.2 miles downstream of Hancock Brook Dam. From field investigations, this dam has a timber crib spillway about 100 feet long and 5 feet high (crest elevation 300 feet NGVD). It has concrete abutments each about 100 feet in length with top elevations about 5 feet above the spillway crest.

(2) <u>Dam 3.3 Miles Downstream of Hancock Brook Dam</u>. This dam is located in Waterbury 3.3 miles downstream of Hancock Brook Dam. From field investigations this dam appears to be a concrete ogee weir structure. It is a run-of-river dam about 8 feet high, with spillway having an approximate crest length of 320 feet at an elevation of 268 feet NGVD.

(3) <u>Platt Bros. Dam</u>. This dam is located in Waterbury about 8.4 miles downstream of Hancock Brook Dam. From field investigations it appears to be a concrete ogee weir structure about 9 feet high, having a spillway length of about 220 feet at elevation 221.0 feet NGVD.

(4) Dam Downstream of Hop Brook. This dam is in the town of Naugatuck about 10.5 miles downstream of Hancock Brook Dam. It is a concrete structure less than 5 feet high, with a spillway length of about 200 feet at elevation 184.4 feet NGVD.

(5) Dam Located Downstream of Route 63. This dam is also located in the town of Naugatuck about 11.3 miles downstream of Hancock Brook Dam. It is another low, less than 5 foot high, dam with a spillway length of about 180 feet at elevation 171.2 feet NGVD.

4. ASSUMED DAM-BREAK CONDITIONS

a. General. The magnitude of a flood resulting from a dam-break depends not only on the size of the project but also on the conditions of failure including the initial reservoir level, size of breach, rate of breach formation, and hydraulic features and initial flows in the downstream river channels. The selected input parameters for the dam-break analysis at Hancock Brook Lake were considered the most severe that might be reasonably expected.

b. Selected Input Parameters. (Base Flood)

(1) Initial Reservoir Level. Full to spillway crest, elevation 484 feet NGVD. Failure storage equals Hancock Brook Lake storage of 3,900 acre-feet.

(2) Reservoir Inflow. Actual August 1955 (flood of record) riverflow 5,800 cfs.

(3) Breach Invert. Elevation 454 feet NGVD.

(4) Breach Base Width. 150 feet, trapezoidal side slopes: 1V:2H.

(5) Time of Complete Formation of Breach. Duration of Breach - one hour.

(6) Prebreak Downstream Flow. August 1955 flood of record as modified by existing system of reservoirs.

(7) Downstream Channel Roughness. From Hancock Brook Dam to dam 3.3 mile downstream of Hancock Brook Dam - Mannings "n" = 0.02 to 0.035. Dam 3.3 miles downstream of Hancock Brook Dam to Beacon Falls - Manning's "n" 0.05 to 0.08.

(8) Downstream Dam Failure. All five dams were assumed to remain.

5. RESULTS

The resulting peak stage flood profile and flood delineations for the base flood are shown on plan and profile sheets 1 and 2 (reference plates 9 and 10). A flood profile index map is shown on plate 8. Timing of peak and leading edge of the flood wave are also noted on the plan and profile plates. The adopted prefailure flow was based on the recurring record August 1955 flood as modi- ied by the present system of reservoirs.

Development of the peak stage profiles, discharge and stage hydrographs for three selected stations downstream of Hancock Brook Lake (river miles 0.00, 4.98 and 17.91) are graphically shown on plate 11.

The peak dam-break discharge for Hancock Brook Lake was 78,300 cfs and attenuated to 60,700 cfs upstream of the junction with the Naugatuck River and then increased to 65,700 cfs downstream of the junction due to the contribution of the Naugatuck River flow of 7,500 cfs. In this 3.0-mile Hancock Brook reach the peak stage resulting from the assumed dam failure would be about 20 feet above normal river level.

Analysis continued downstream along the Naugatuck River for an additional distance of 15.7 miles. In this reach of the Naugatuck River, there are the several small dams previously described. These dams have little effect on peak flood stages. Also within this reach, peak flows and stages of the dam-break flood were influenced to a degree by coincident inflows from Steel and Hop Brooks, Mad River and local inflows (see plate 11): "Discharges vs Distance for Dam Breach Flood". Peak discharges would be attenu- ated through this reach from 65,700 to 55,800 cfs and peak stages would be about 10 to 20 feet above normal river level. At Beacon Falls, the peak flood stage would be approxi- mately 10 feet above normal river level, or about 5 feet above the assumed prebreak high flow and about 5 feet below the natural August 1955 flood- flow.

The leading edge of the dam-break flood would reach Inter- state Route 84 in Waterbury about 1.0 hour after the start of the failure and the resulting peak flood stage would occur approxi- mately 2.0 hours after the start of dam-break. Similarly, the leading edge of the dam-break would reach Beacon Falls about 2 hours after the start of the failure and the resulting peak flood stage would occur approximately 3.90 hours after the start of dam- break.

The computer analysis was ended at Beacon Falls (dam-break mile 17.91). Peak stages of the flood wave at Beacon Falls would be about 5 feet below the peak stage of the record August 1955 flood, and not more then 5 feet above prefailure high flow level. The 5 foot failure surcharge would continue to attenuate progressing downstream of Beacon Fall.

6. SENSITIVITY TESTS

In addition to the analysis with the assumed dam-break conditions, other studies were made to determine the sensitivity that individual selected parameters would have on the resulting downstream flood. Following is a listing of conditions used and a description of results obtained.

a. Breach Width. Runs were made with the initially adopted breach width of 150 feet and a comparative breach width of 300 feet. There were only minor stage increases in the upper study reach and no increases further downstream. Comparative profiles for the two breach widths are shown on plate 12.

b. Duration of Dam-Break. Though the selected duration for the failure time was 1 hour, runs were also made for failure times of both 3 and 5 hours. Changes in failure time resulted in stage reductions of up to 10 feet in the upper portions of the study reach and 4 feet reductions in the lower reaches. The relative effects of the three failure times on downstream flood profiles are illustrated on plate 12.

c. Initial Pool Level. An important factor in determining the magnitude of a dam-break flood is the level of the reservoir when the break occurs. Though a full reservoir condition was adopted, a run was also completed with the reservoir initially one-half full. Comparative downstream profiles are shown on plate 13. With the one-half full condition, the resulting peak discharge at Hancock Brook Lake was 36 percent less than the adopted full pool condition. Peak flood levels, within the study reach, were from 6 to 2 feet less.

d. Channel Roughness. Manning's "n" sensitivity tests were made to determine their effect on downstream flood attenuation, resulting stages and timing. Tests were made with the Manning's "n" 20 percent greater. Increasing the channel roughness resulted in slower progression downstream with somewhat greater attenuation; however, the resulting variation in downstream flood profile was relatively small as illustrated on plate 13. Also varying the channel roughness had little effect in timing of the peak flood stage. At Platt Brothers Dam in Waterbury, (dam-breach mile 8.35) the timing varied from 2.55 to 2.57 hours and at end of the study reach (dam-breach mile 17.91) the timing varied from 4.85 to 5.07 hours for the adopted and increased "n" values, respectively.

e. Antecedent Riverflows. The base dam-break flood analysis assumed a high flow already occurring in the river at time of dam-break. This was considered appropriate since if a dam-break were to occur, it is highly probable that it would occur at a time of abnormally high flow conditions. The base flow conditions were selected as the recurring record August 1955 flood as modified by the presently existing system of Corps flood control reservoirs, namely, Hall Meadow Brook, East Branch, Thomaston, Northfield Brook, Black Rock, Hancock Brook and Hop Brook projects, which were all constructed following the August 1955 event.

The Hancock Brook Lake outflow with the reservoir at spillway crest was 500 cfs which would have been the approximate discharge for the August 1955 flood. Progressing downstream, inflows to the study reach were as follows: 7,500 cfs from the Naugatuck River, 2,000 cfs from a local, 9,000 cfs from Steel Brook and the Waterbury local, 4,000 cfs from Mad River, 2500 cfs from Hop Brook and 8,000 cfs from local tributaries. The resulting total prefailure flow at Beacon Falls was 33,500 cfs. The adopted antecedent flows and comparative experienced August 1955 discharges were as follows:

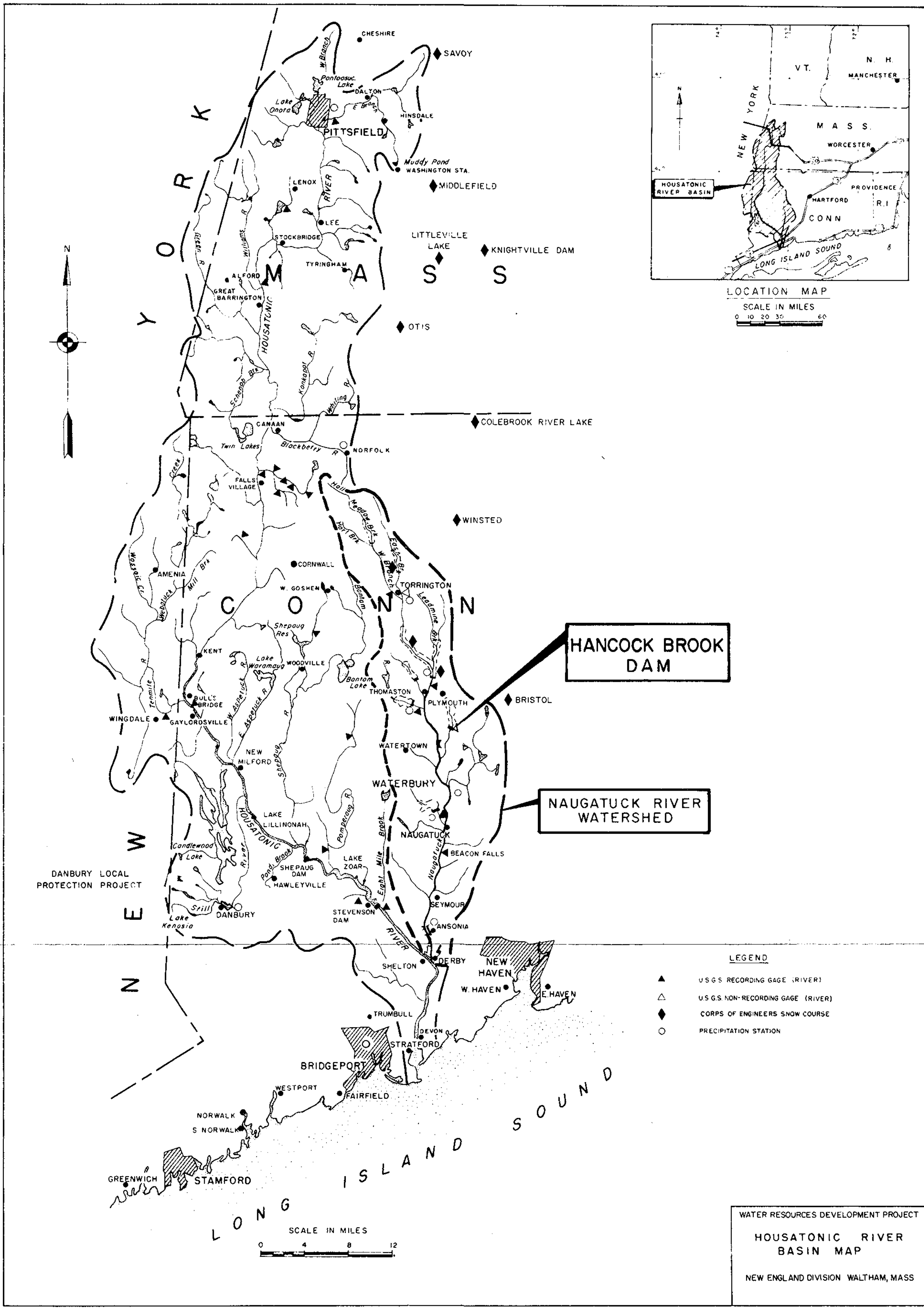
	Adopted Antecedent (cfs)	Experienced August 1955 (cfs)
Hancock Brook	500	5,800
At Waterbury	10,000	90,000
At Beacon Falls Gage	33,500	106,000

A sensitivity analysis was also made assuming a lower (50 percent of the base flood antecedent flow) antecedent riverflow at time of dam-break. Comparative flood stages are illustrated on plate 14.

d. Downstream Dams. As noted previously, there are five dams downstream of Hancock Brook within the study reach. In the event of a major dam-break at Hancock Brook, under full pool conditions, these dams could be seriously damaged or fail; however, there is no significant storage behind any of the five dams. A failure of any of these dams coincident with a Hancock Brook Dam failure would not cause a significant added increase in flow or stage upstream or downstream of the structures.

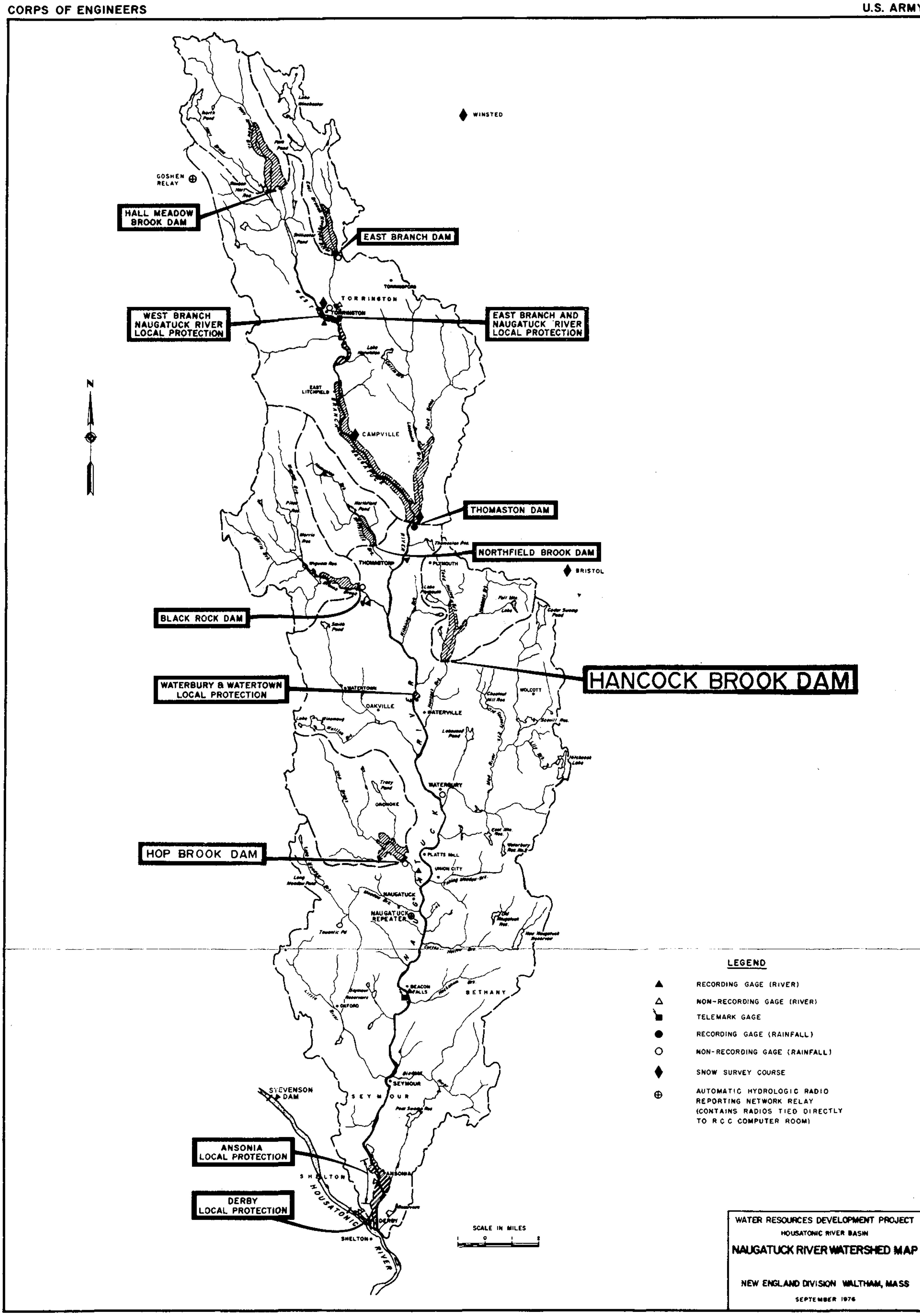
7. DISCUSSION

The dam-break analysis for Hancock Brook Dam was based on engineering application of certain laws of Physics, considering the physical characteristics of the project and downstream channel, and conditions of failure. Due to the highly unpredictable nature of a dam-break and the ensuing sequence of events, the results of this study should not be viewed as exact but only as an approximate quantification of the dam-break flood potential. For purposes of analysis, downstream conditions are assumed to remain constant and no allowance is made for possible enlargement or relocation of the river channel due to scour or the temporary damming effect of debris all of which could affect, to some extent, the resulting magnitude and timing of flooding downstream.



HANCOCK BROOK DAM
NAUGATUCK RIVER WATERSHED
DANBURY LOCAL PROTECTION PROJECT
LOCATION MAP
SCALE IN MILES
HOUSATONIC RIVER BASIN
LEGEND
U.S.G.S. RECORDING GAGE (RIVER)
U.S.G.S. NON-RECORDING GAGE (RIVER)
CORPS OF ENGINEERS SNOW COURSE
PRECIPITATION STATION
SCALE IN MILES
LONG ISLAND SOUND
NEW YORK
MASS
CONN
PITTSFIELD
WATERBURY
BRIDGEPORT
STAMFORD
NEW HAVEN
WATER RESOURCES DEVELOPMENT PROJECT
HOUSATONIC RIVER BASIN MAP
NEW ENGLAND DIVISION WALTHAM, MASS

PLATE 1

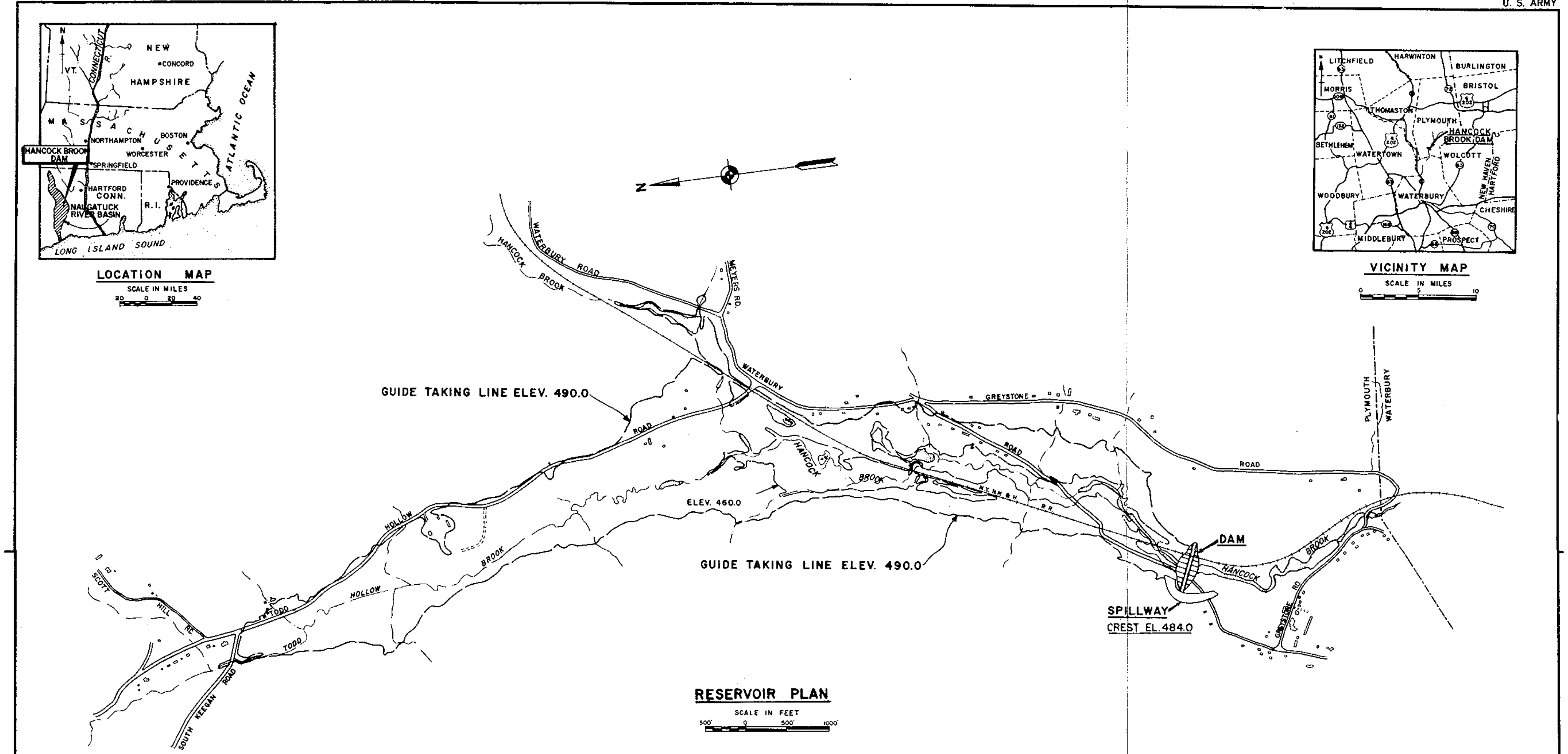


WATER RESOURCES DEVELOPMENT PROJECT
HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED MAP
NEW ENGLAND DIVISION WALTHAM, MASS
SEPTEMBER 1976

PLATE 2

CORPS OF ENGINEERS

U. S. ARMY



REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DR. BY	TR. BY	CK. BY
	M.W.B.	

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF, PLANN & RPTS BRANCH

HOUSATONIC RIVER FLOOD CONTROL

HANCOCK BROOK DAM

RESERVOIR MAP

HANCOCK BROOK CONNECTICUT

APPROVED DATE DEC. 1961

CHIEF ENGINEERING DIV.

SCALE SPEC. NO CIV ENG-19-016-

DRAWING NUMBER

SHEET

View of Hancock Brook

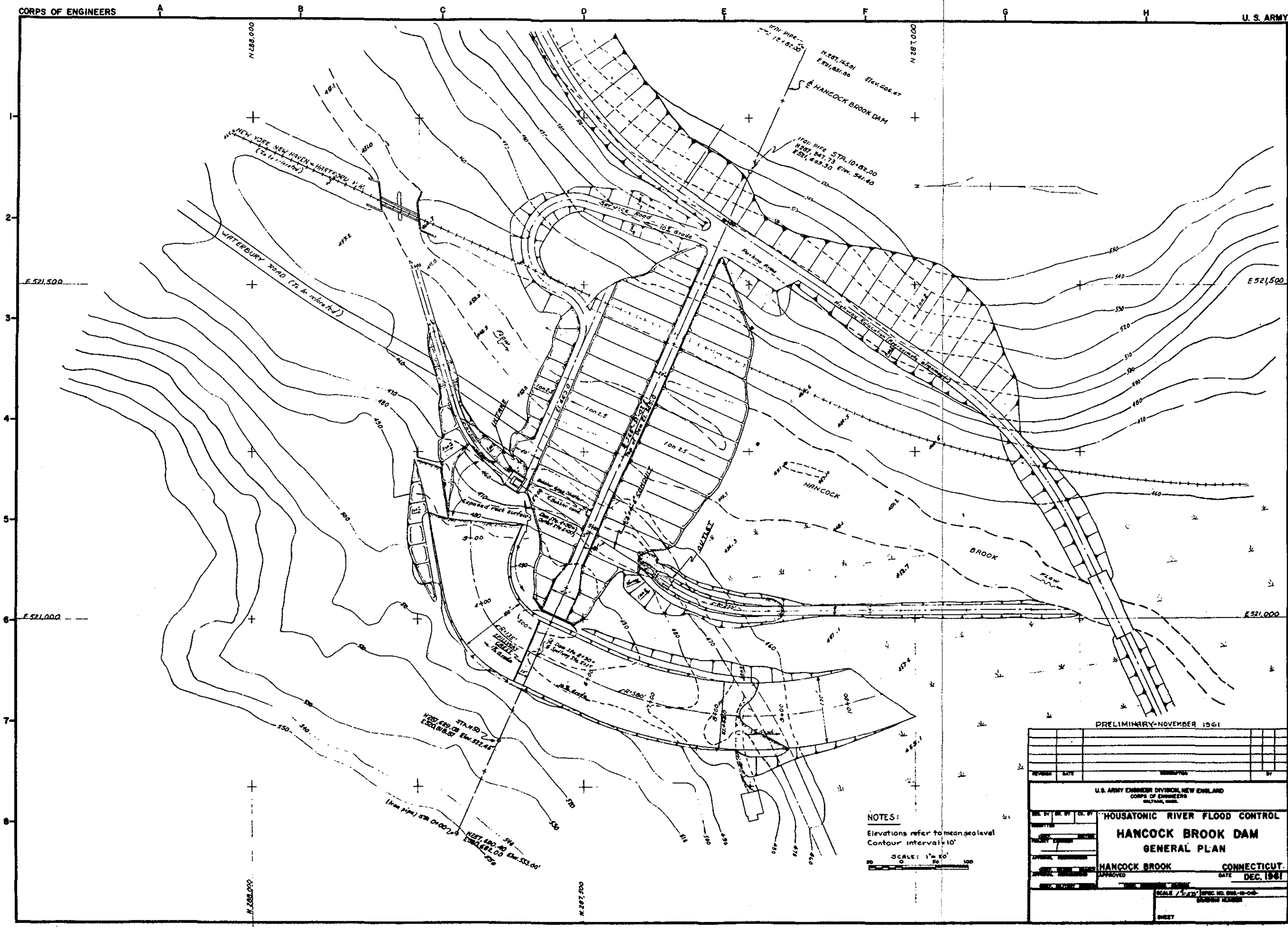
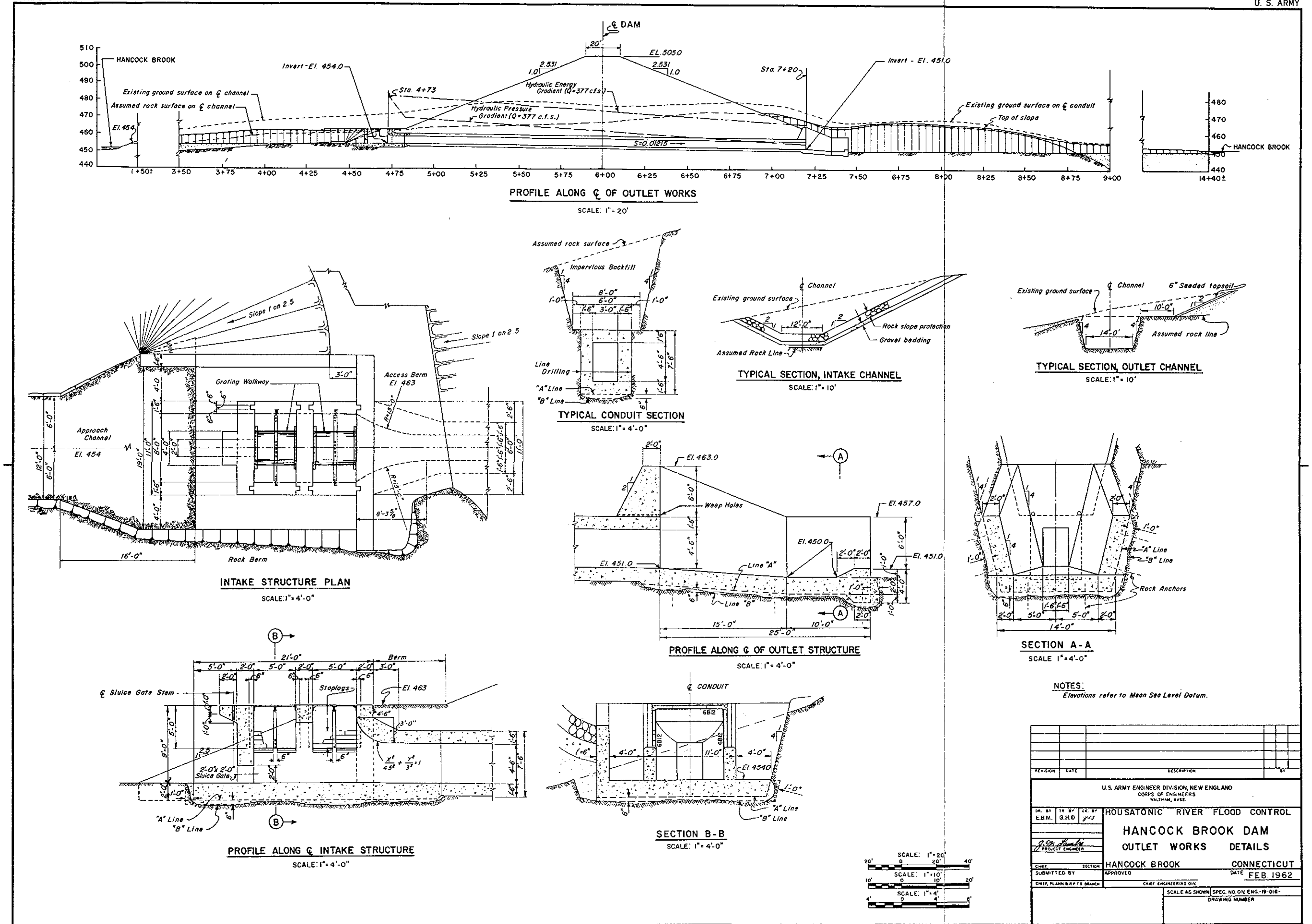
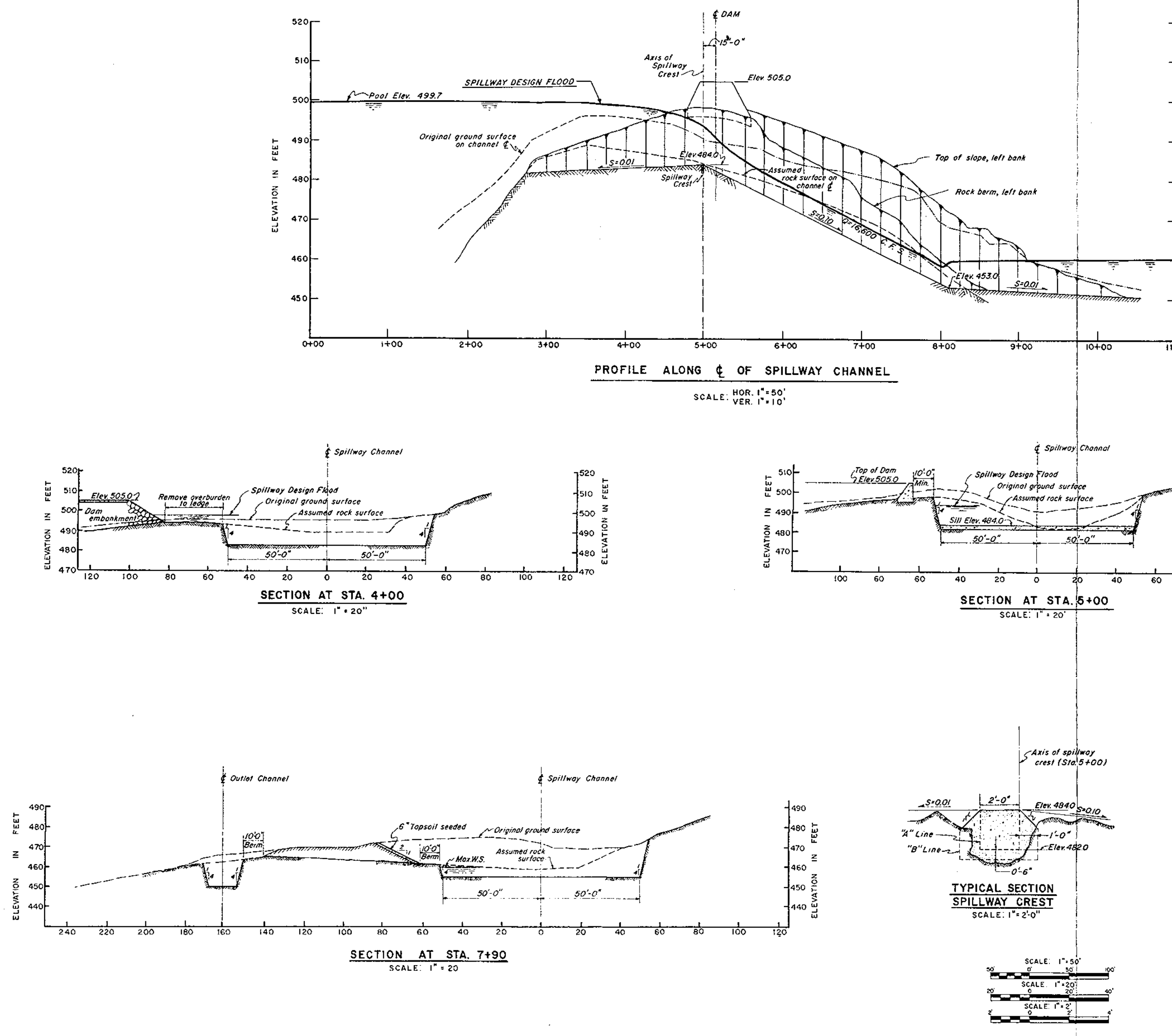

CORPS OF ENGINEERS
U. S. ARMY
HANCOCK BROOK DAM
NEW YORK NEW HAVEN & HARTFORD R.R.
WATERBURY ROAD
Service Road
Parking Area
HANCOCK
BROOK
PRELIMINARY-NOVEMBER 1961
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
HOUSATONIC RIVER FLOOD CONTROL
HANCOCK BROOK DAM
GENERAL PLAN
HANCOCK BROOK
CONNECTICUT.
DEC. 1961
NOTES:
Elevations refer to mean sea level
Contour interval=10'
SCALE: 1"=50'

PLATE 5


PROFILE ALONG ℄ OF OUTLET WORKS
SCALE: 1" = 20'
℄ DAM
HANCOCK BROOK
Existing ground surface on ℄ channel
Assumed rock surface on ℄ channel
Invert - El. 454.0
Sta. 4+73
Hydraulic Energy Gradient (Q=377 c.f.s.)
Hydraulic Pressure Gradient (Q=377 c.f.s.)
EL. 505.0
S=0.01215
Sta. 7+20
Invert - El. 451.0
Existing ground surface on ℄ conduit
Top of slope
TYPICAL CONDUIT SECTION
SCALE: 1" = 4'-0"
Assumed rock surface
Impervious Backfill
Line Drilling
"A" Line
"B" Line
TYPICAL SECTION, INTAKE CHANNEL
SCALE: 1" = 10'
Existing ground surface
Rock slope protection
Gravel bedding
Assumed Rock Line
TYPICAL SECTION, OUTLET CHANNEL
SCALE: 1" = 10'
6" Seeded topsoil
Assumed rock line
INTAKE STRUCTURE PLAN
SCALE: 1" = 4'-0"
Slope 1 on 2.5
Grating Walkway
Access Berm El. 463
Approach Channel El. 454
Rock Berm
PROFILE ALONG ℄ OF OUTLET STRUCTURE
SCALE: 1" = 4'-0"
El. 463.0
Weep Holes
El. 457.0
El. 450.0
El. 451.0
Line "A"
Line "B"
SECTION A-A
SCALE 1" = 4'-0"
Rock Anchors
PROFILE ALONG ℄ INTAKE STRUCTURE
SCALE: 1" = 4'-0"
℄ Sluice Gate Stem
Stoplogs
Berm
El. 463
2'-0" x 2'-0" Sluice Gate
SECTION B-B
SCALE: 1" = 4'-0"
℄ CONDUIT
El. 454.0
NOTES:
Elevations refer to Mean Sea Level Datum.
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
HOUSATONIC RIVER FLOOD CONTROL
HANCOCK BROOK DAM
OUTLET WORKS DETAILS
HANCOCK BROOK
CONNECTICUT
DATE FEB. 1962
SCALE AS SHOWN
SPEC. NO. CIV. ENG.-19-016-



NOTES:
Elevations refer to Mean Sea Level Datum

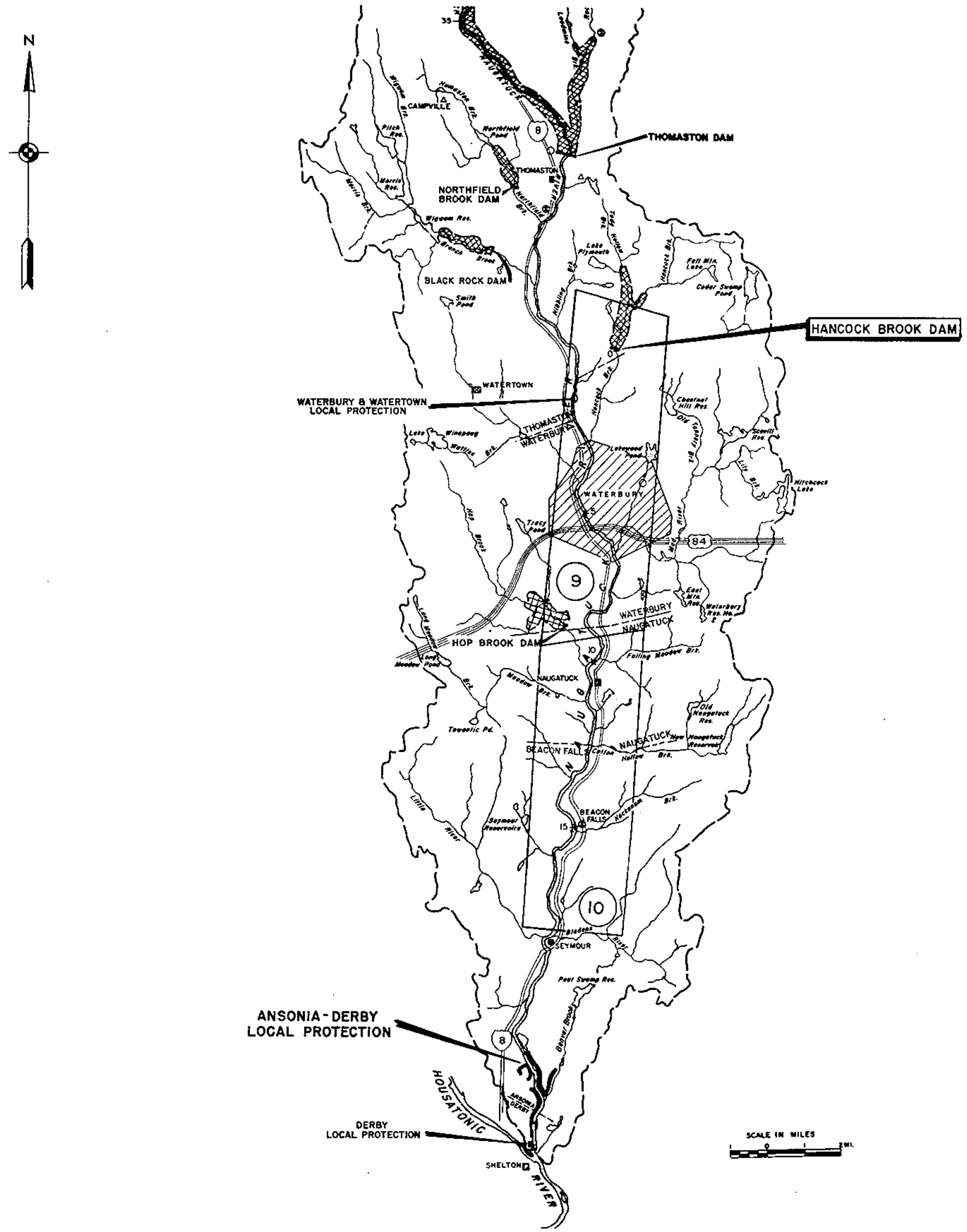
REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY H.B.F. TR. BY M.W.B. CK. BY

HOUSATONIC RIVER FLOOD CONTROL
HANCOCK BROOK DAM
SPILLWAY PROFILE & SECTIONS
HANCOCK BROOK CONNECTICUT

PROJECT ENGINEER
SUBMITTED BY
APPROVED
DATE FEB. 1962
CHIEF, PLANS & RPTS BRANCH
CHIEF, ENGINEERING DIV.
SCALE AS SHOWN SPEC. NO. CIV ENG-19-016-
DRAWING NUMBER
SHEET



CROSS SECTION DATA						
				DAM BREACH FLOOD		
PLATE NO.	SECTION NO.	RIVER MILE	DIST. D/S FROM DAM (MI.)	ARRIVAL * TIME (HOURS)	PEAK TIME *(HOURS)	PEAK EL. (FT.-NGVD)
8	0.90	0.90	0.90	0.10	1.02	397.8
8	2.22	2.22	2.22	0.20	1.05	308.2
8	3.70	3.70	3.70	0.60	1.40	286.3
8	5.73	5.73	5.73	1.00	2.00	270.5
8	8.35	8.35	8.35	1.20	2.55	230.7
9	9.50	9.50	9.50	1.40	3.00	214.2
9	12.57	12.57	12.57	1.80	3.75	272.8
9	15.39	15.39	15.39	2.10	4.45	126.7
9	17.91	17.91	17.91	2.50	4.85	96.4

* FROM START OF BREACH FORMATION

LEGEND

- U.S. GEOLOGICAL SURVEY GAGING STATION
- CITIES
- FLOOD CONTROL DAM SITES
- +10 RIVER MILES DOWNSTREAM FROM HANCOCK BROOK DAM
- INUNDATION MAP PLATE ⑨ — LOCATION OF MAP PANELS

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED

HANCOCK BROOK DAM BREACH FLOOD

INDEX MAP

NAUGATUCK RIVER CONNECTICUT

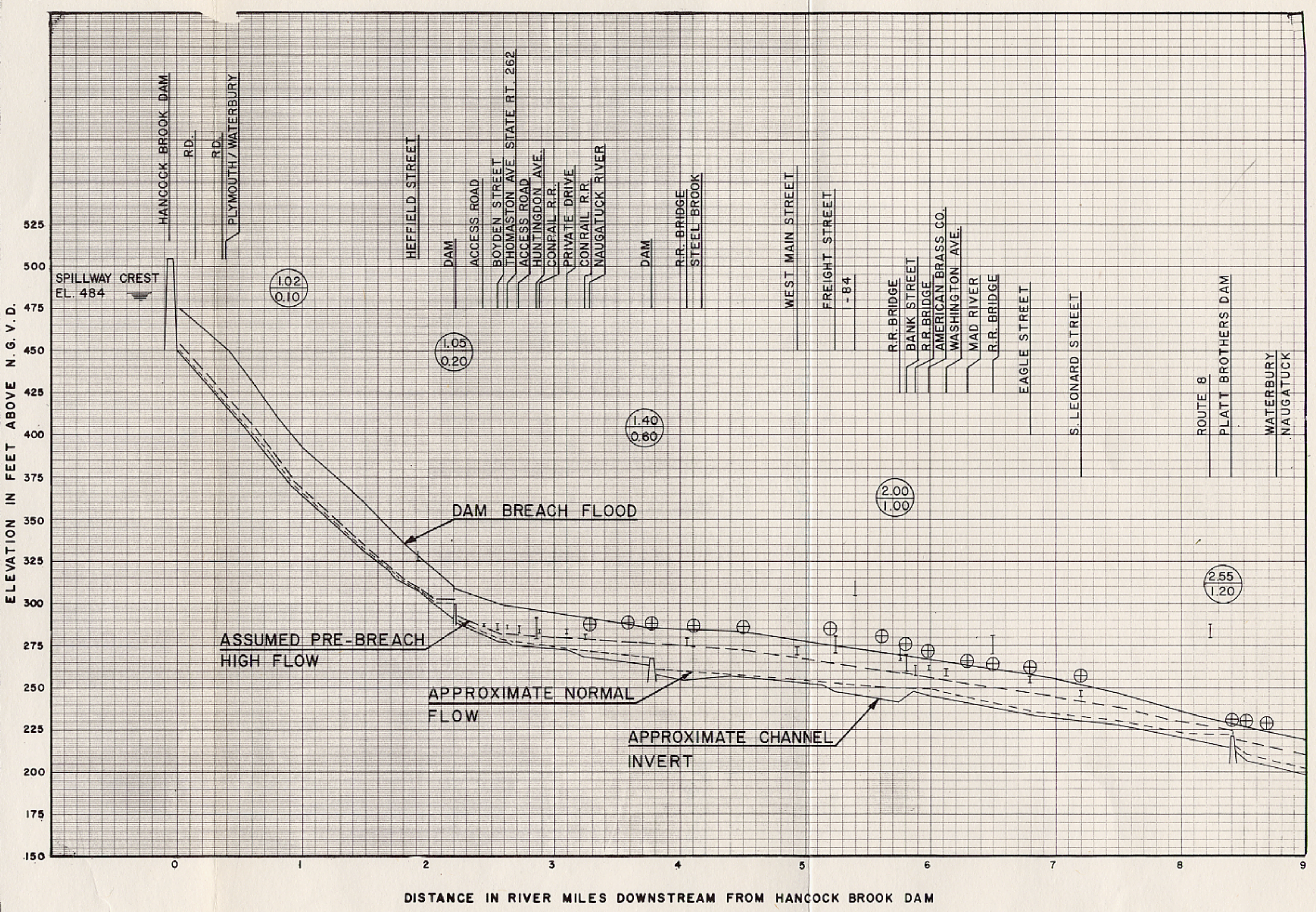
HYDRO. ENGR. SECT. 1985

PLATE 8

PLAN

SCALE: 1" = 2000'

2000' 0 2000' 4000'
FEET



LEGEND

- ⊕ EXPERIENCED AUGUST 1955 FLOOD ELEVATIONS
- 1.05 / 0.20 — HOURS FROM START OF FAILURE / HOURS TO INITIAL RIVER RISE
- LIMITS OF BREACH FLOOD

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED

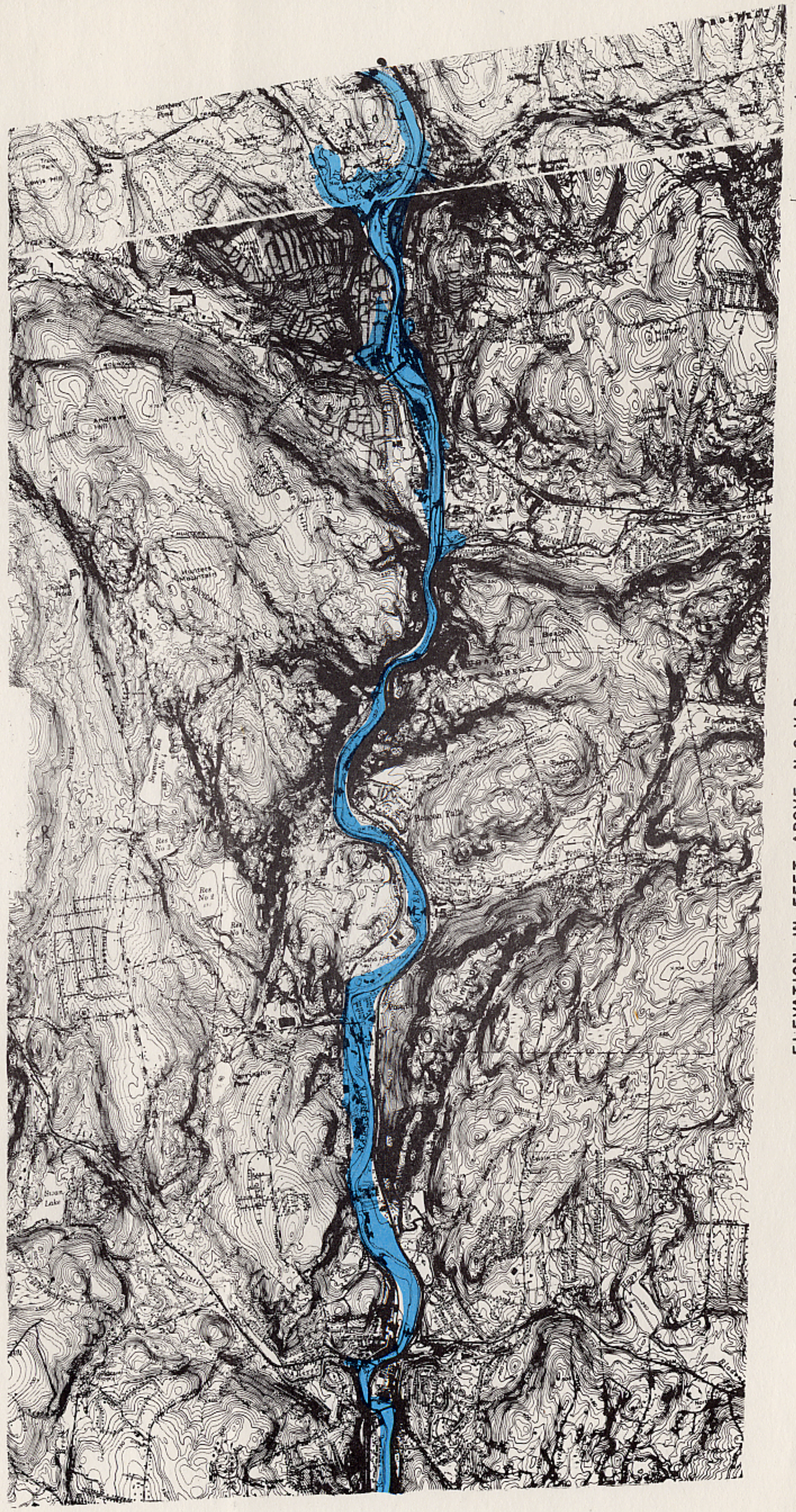
HANCOCK BROOK DAM BREACH FLOOD

PLAN & PROFILE #1

NAUGATUCK RIVER — CONNECTICUT

HYDRO. ENGR. SECT. — 1985

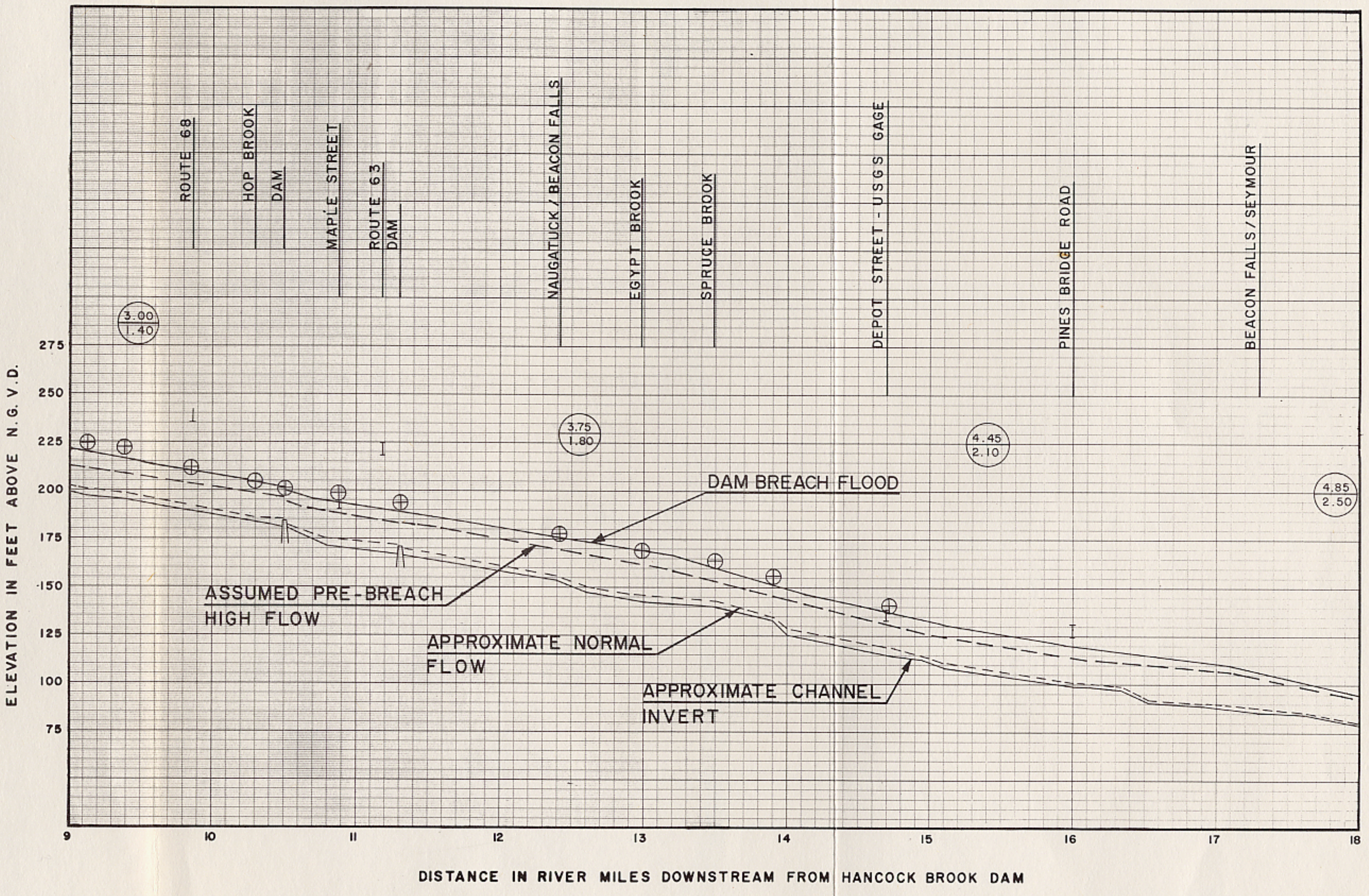
U. S. ARMY



PLAN

SCALE: 1" = 2000'

2000' 0 2000' 4000'
FEET



LEGEND

⊕ EXPERIENCED AUGUST 1955 FLOOD ELEVATIONS

3.75 HOURS FROM START OF FAILURE
1.80 HOURS TO INITIAL RIVER RISE

LIMITS OF BREACH FLOOD

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

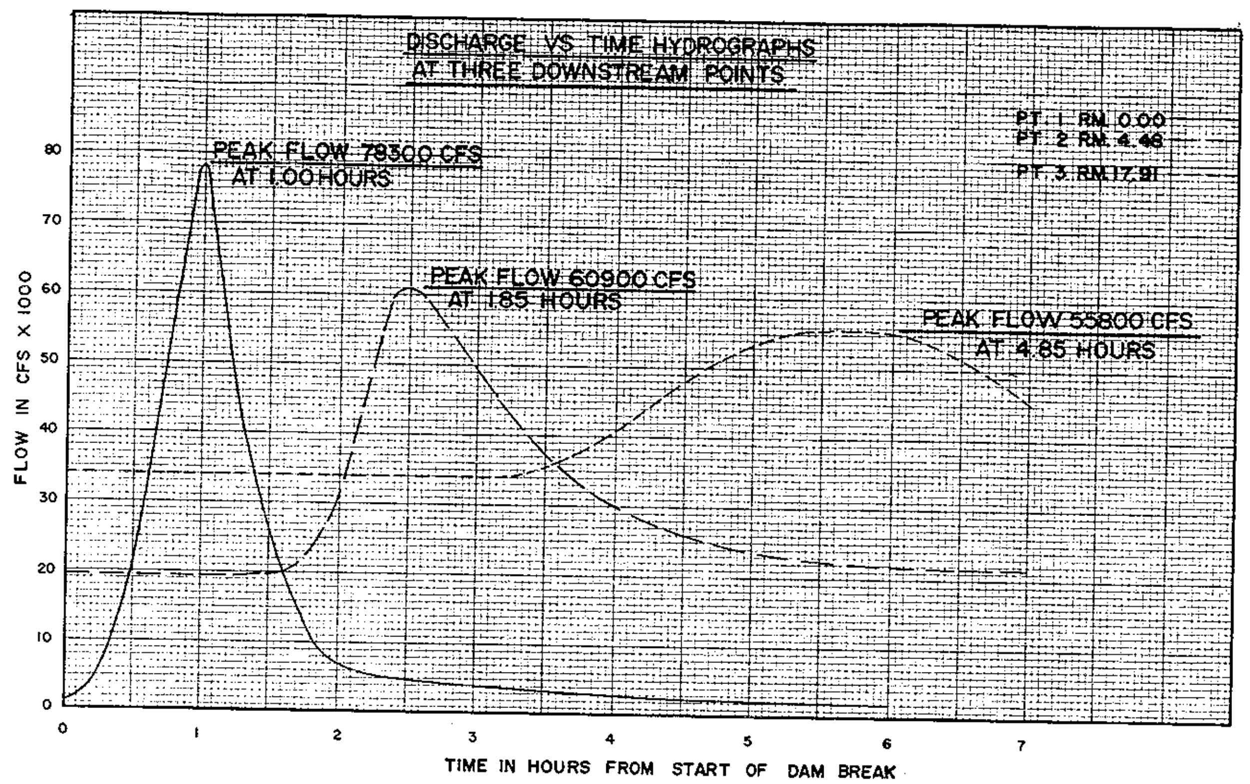
HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED

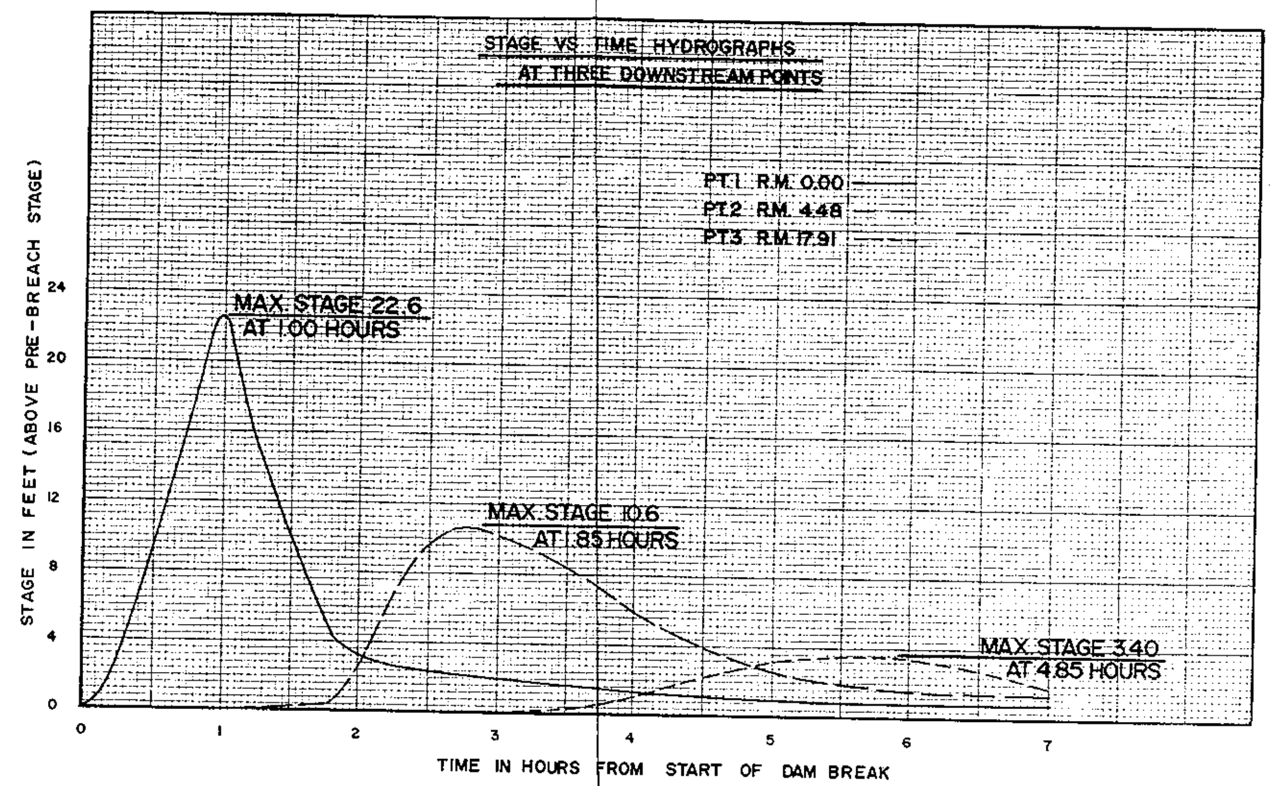
HANCOCK BROOK DAM BREACH FLOOD
PLAN & PROFILE #2

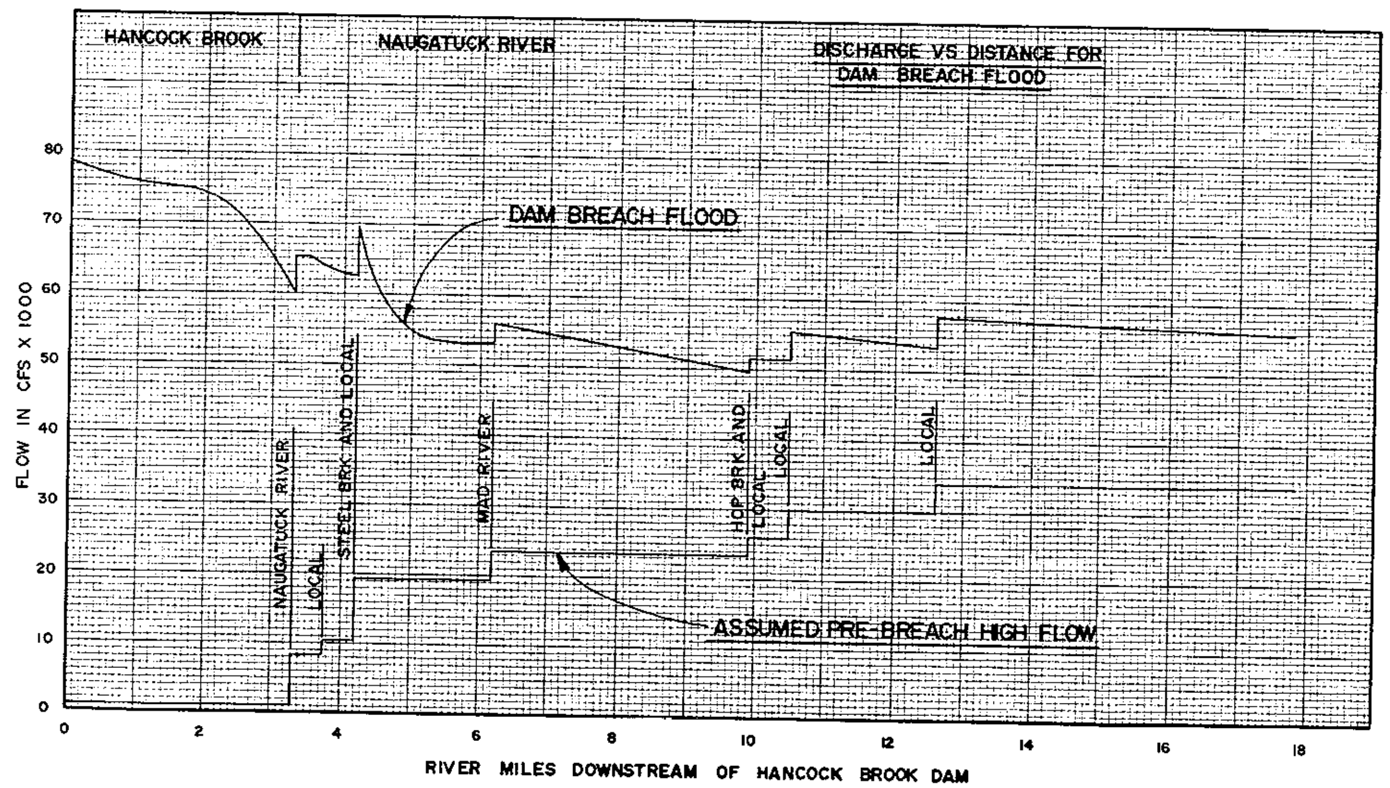
NAUGATUCK RIVER — CONNECTICUT

HYDRO. ENGR. SECT. — 1985

PLATE 10







DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED

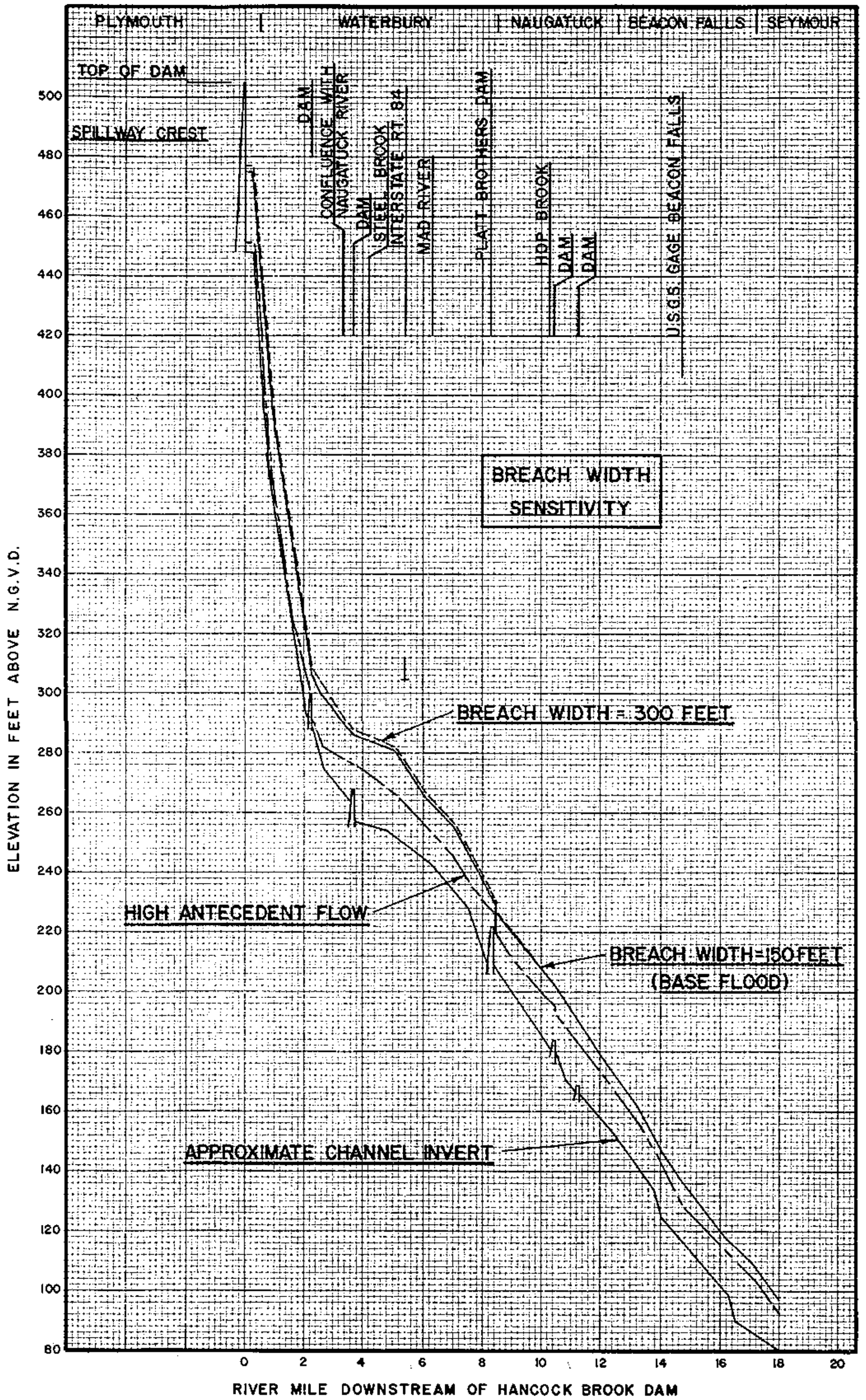
HANCOCK BROOK DAM BREACH FLOOD

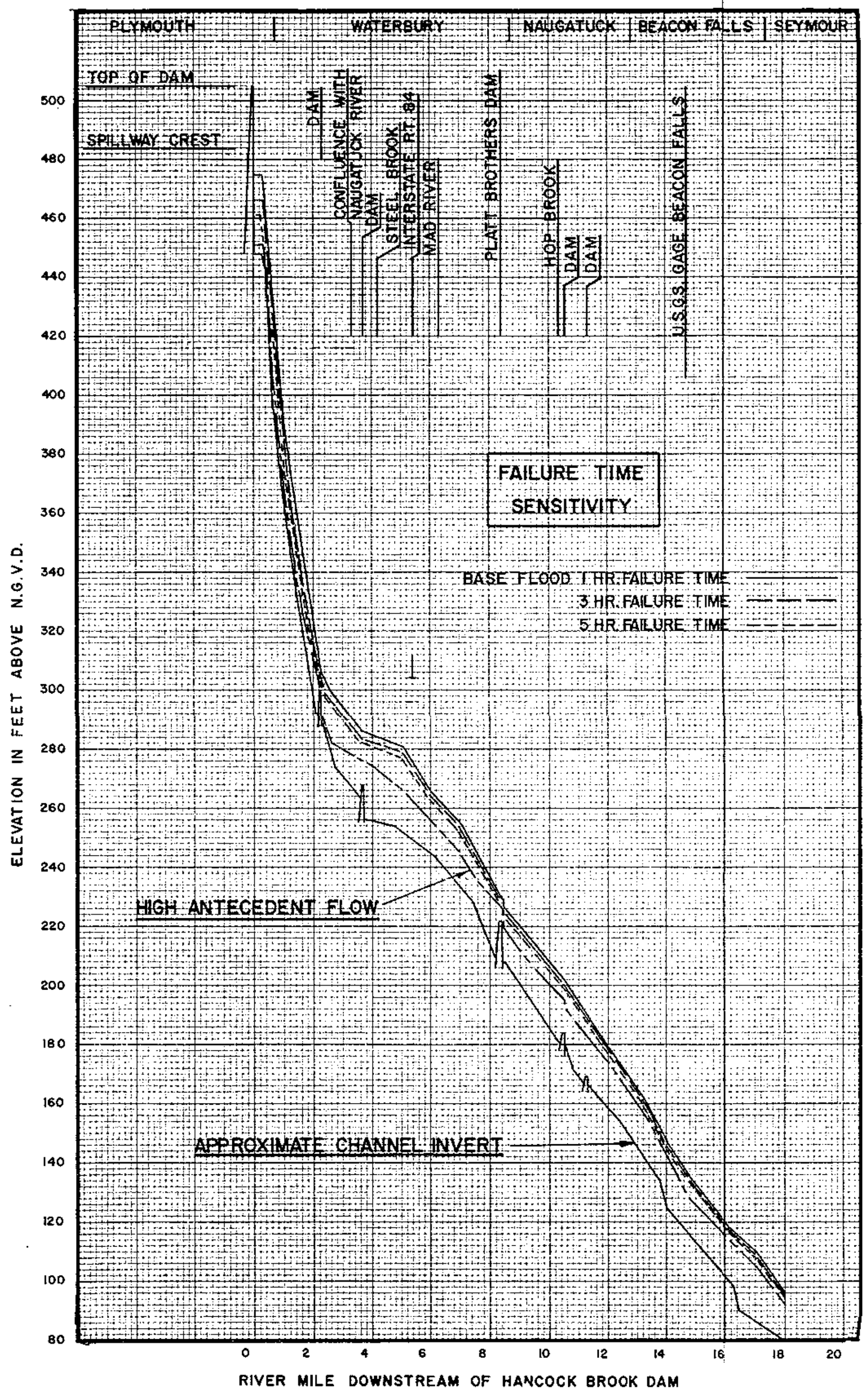
FLOOD DISCHARGES, STAGES AND TIMING

NAUGATUCK RIVER — CONNECTICUT

HYDRO. ENGR. SECT. — SEPTEMBER 1985

PLATE 11





DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED

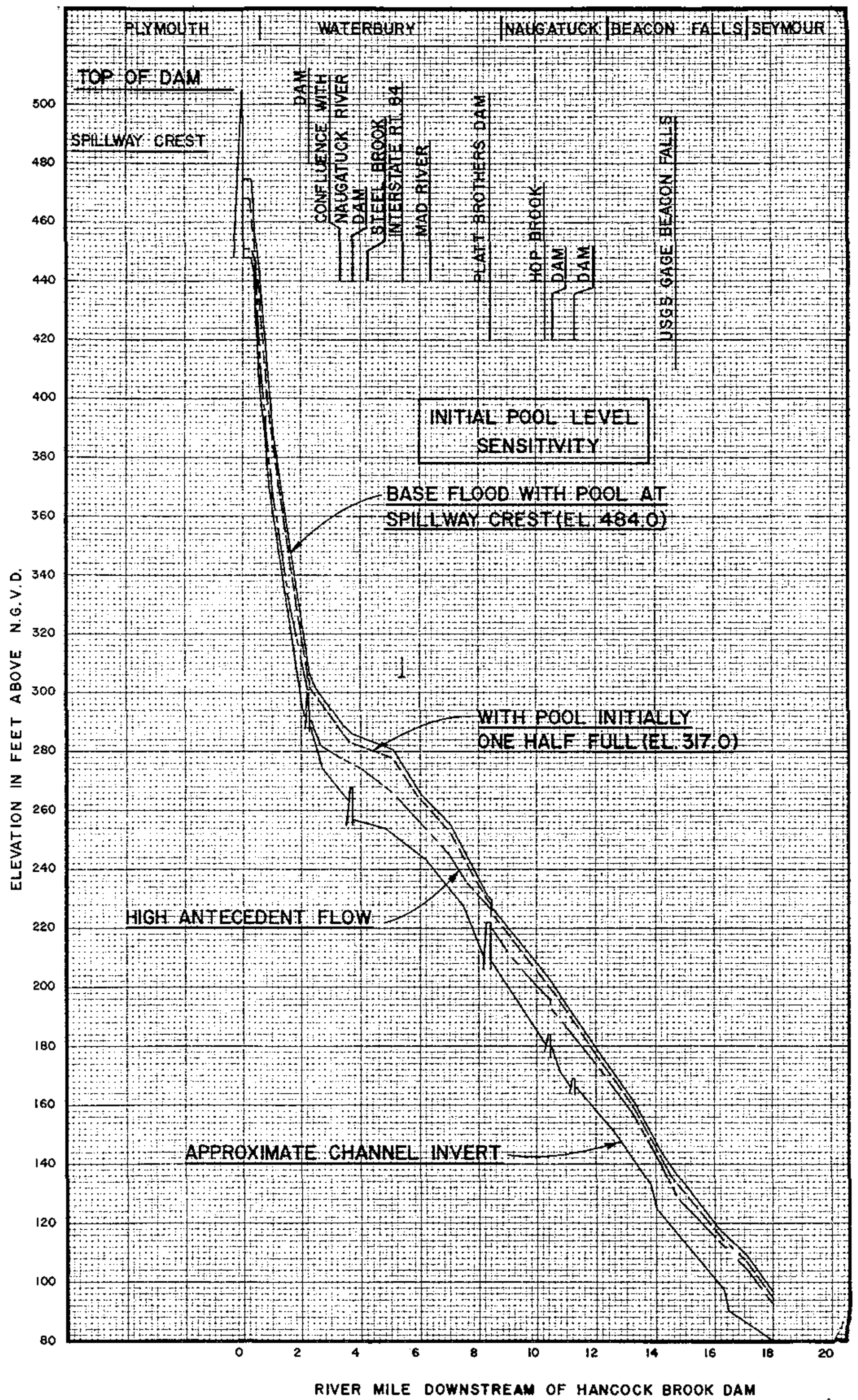
HANCOCK BROOK DAM BREACH FLOOD

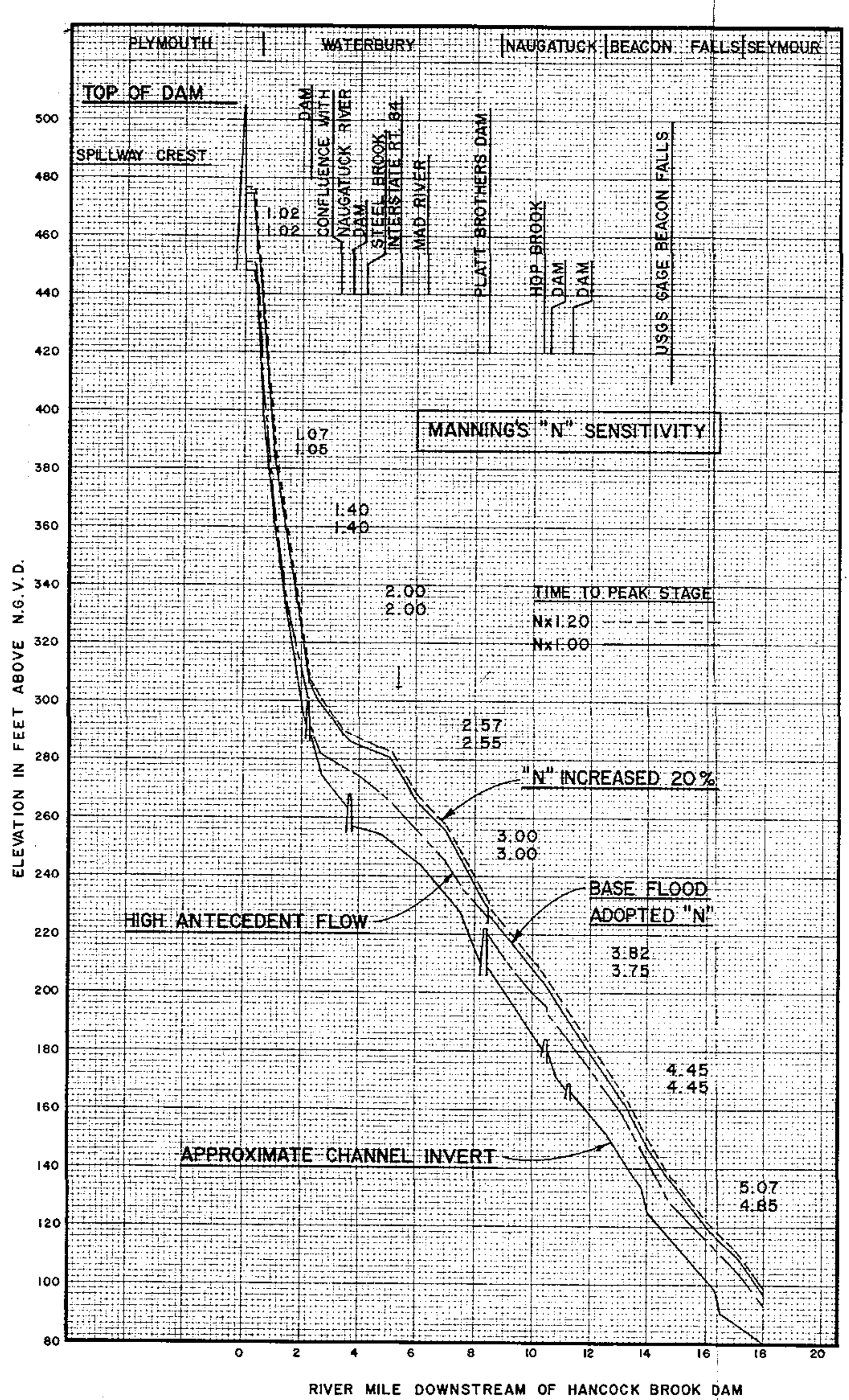
SENSITIVITY OF INPUT PARAMETERS NO. 1

NAUGATUCK RIVER CONNECTICUT

HYDRO. ENGR. SECT. SEPTEMBER 1985

PLATE 12





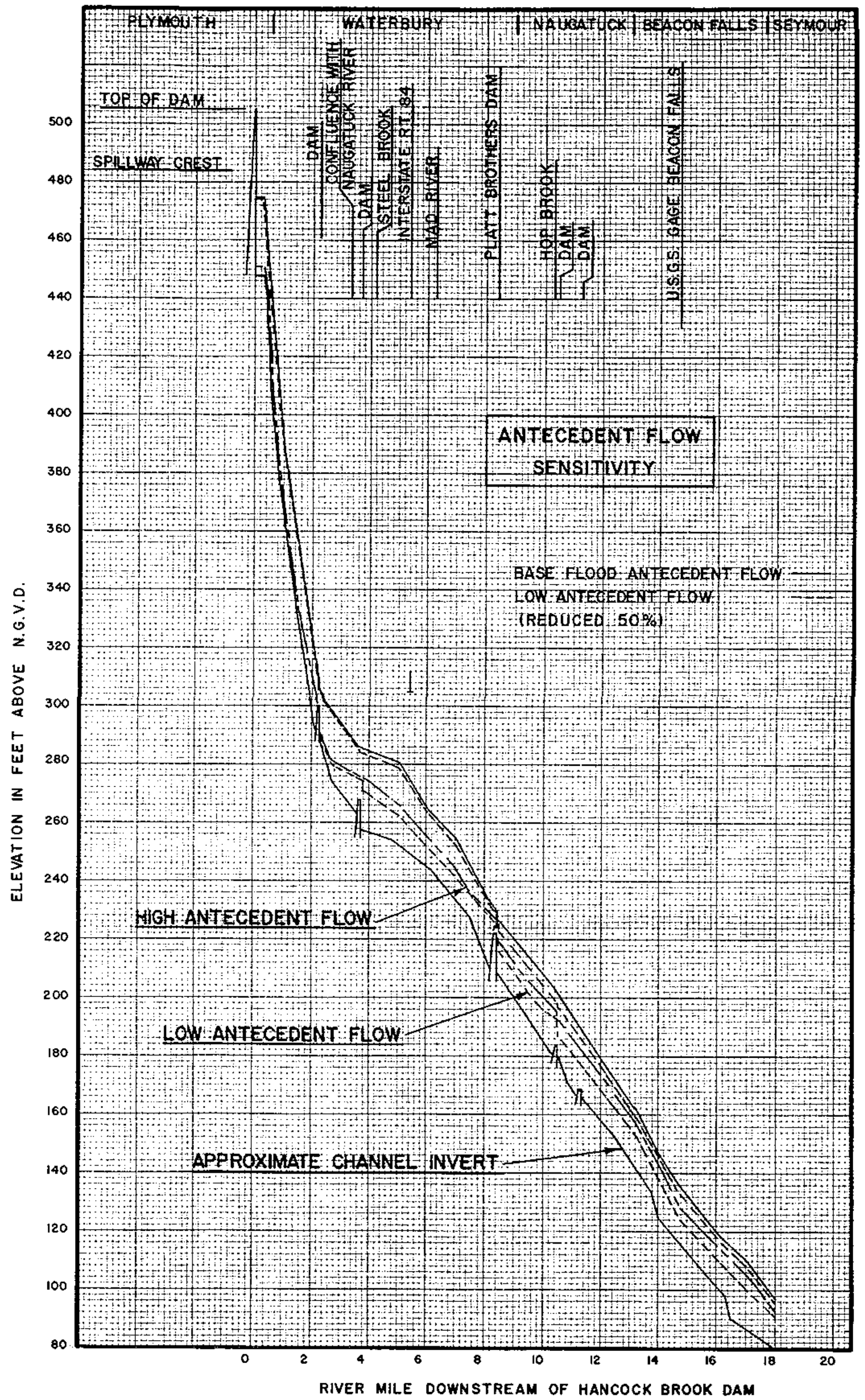
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED

HANCOCK BROOK DAM BREACH FLOOD
SENSITIVITY OF INPUT
PARAMETERS NO. 2

NAUGATUCK RIVER CONNECTICUT

HYDRO. ENGR. SECT. SEPTEMBER 1985



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED

HANCOCK BROOK DAM BREACH FLOOD
SENSITIVITY OF INPUT
PARAMETERS NO. 3

NAUGATUCK RIVER | CONNECTICUT

HYDRO. ENGR. SECT. | SEPTEMBER 1985

PLATE 14

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*HECFORMAT
*ECHO
*FREEFORMATTED
*COMPOSITE
ID,,HANCOCK BROOK LAKE CONN
ID,,NAUGATUCK RIVER
ID,,MIKE MICHIELUTTI C OF E  NED
ID,,424 TRAPELO DOAD
ID,,WALTHAM MASS 02254
IO,3,6,0
IP,3,4
QI,5800,5600,2800,2000,1500
QT,0,2,4,6,8
SN,,HANCOCK BROOK LAKE
SE,484,479,474,469,466,463,459,450
SA,266,231,186,137,104,70,34,0
DN,,HANCOCK BROOK LAKE
DD,505,484,0,484,50,,.08,450
DB,1,484,150,450,2
DO,1000,280,0,1560
RN,,REACH 1 HANCOCK BRK LK DM TO D/S 2ND REACH ( SUP-CRIT-FLW )
RP,4,0,-1
RG,1,3,5
RC,0.00
XI,0.00,0.00,,,,,.10
XE,450,460,470,480,490,500,505,510
XC,50,75,100,200,700,810,900,1000
XO
NC,.02,.02,.025,.025,.03,.03,.035,.035
XI,0.50,0.50,,,,,.10
XE,418,425,430,440,450,460,470,480
XC,35,50,75,110,160,200,250,300
XO
NC,.02,.02,.025,.025,.03,.03,.035,.035
XI,0.90,0.90,,,,,.10
XE,370,380,390,400,410,420,430,440
XC,30,50,60,100,150,190,250,300
XO
NC,.02,.02,.025,.025,.03,.03,.035,.035
XI,1.50,1.50,,,,,.10
XE,330,340,350,360,370,380,390,400
XC,30,50,60,90,120,150,170,200
XO
NC,.02,.02,.025,.025,.03,.03,.035,.035
XI,2.22,2.22
XE,294,296,298,300,310,320,330,350
XC,30,50,120,200,300,410,520,700
XO
RN,REACH 2 TO DAM UPSTREAM OF U/S OF STEEL BROOK
RP,4,0,-1
RG,2,4
RC,0.25
RH,268,272,277,280,283,285,288,290
RQ,0,5000,10500,30000,50000,60000,74000,85000
XI,2.32,2.32,,,,,.05
XE,288,290,295,300,305,307,310,315
XC,200,250,800,1100,1550,1600,1700,2500
XO
```

```
NC,.05,.05,.055,.055,.06,.06,.065,.065
XI,2.70,2.70,,,,,.05
XE,275,280,285,290,295,300,310,315
XC,200,250,500,800,900,1000,1200,1860
XO,0,0,600,700,700,700,800,900
NC,.05,.05,.055,.055,.06,.06,.065,.065
XI,3.30,3.30,,,,,.05
QN,3.30,,NAUGATUCK RIVER MAIN STEM
QL,7500,7500,7500,7500,7500
XE,270,276,280,286,287,300,301,350
XC,160,240,480,520,660,800,1100,1440
XO,0,0,0,0,500,600,600,1000
NC,.05,.05,.055,.055,.06,.06,.065,.065
XI,3.70,3.70
QN,3.70,,LOCAL INFLOW
QL,2000,2000,2000,2000,2000
XE,264,276,280,285,290,295,300,310
XC,350,350,400,1400,2300,3000,3500,4000
XO,0,0,0,600,1000,1400,1600,1500
ZZ
EOF
EOT..
E>
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```
*HECFORMAT
*ECHO
*FREEFORMATTED
*COMPOSITE
ID,,HANCOCK BROOK LAKE CONN
ID,,NAUGATUCK RIVER
ID,,MIKE MICHIELUTTI C OF E  NED
ID,,424 TRAPELO DOAD
ID,,WALTHAM MASS 02254
IO,9,6,0
IP,3,4
QI,5800,5600,2800,2000,1500
QT,0,2,4,6,8
SN,,HANCOCK BROOK LAKE
SE,324,319,314,309,306,303,299,291.5
SA,266,231,186,137,104,70,34,0
DN,,HANCOCK BROOK LAKE
DD,345,324,0,324,50,,.08,291.5
DB,1,324,150,291.5,2
DO,1000,280,0,1560
DN,,DAM U/S STEEL BROOK
DD,280,268,0.0,,4,,.04
DB,1,276,200,264,2
DO,0,640,0,840
DN,,PLATT BROTHERS DAM
DD,228,221.3,0,,15,,.04
DO,0,1812,0,150
DN,,DAM D/S HOP BROOK JCT
DD,210,184.4,,,16,,.04
DO,0,704,0,1000
RN,,REACH 2 TO DAM U/S OF STEEL BROOK
RP,4,0,-1
RG,2,4
RC,276.61
XI,2.32,2.32,,,,,.10
XE,288,290,295,300,305,309,310,315
XC,100,400,700,850,1000,1300,1500,2700
XO
NC,,.08,,.085,,.085,,.09,,.09,,.095,,.0955,,.10
XI,2.85,2.85,,,,,.10
XE,274,280,285,290,295,300,310,315
XC,200,250,800,1100,1550,1600,1700,2600
XO
NC,,.08,,.085,,.085,,.09,,.09,,.095,,.0955,,.10
XI,3.30,3.30,,,,,.15
QN,3.30,,NAUGATUCK RIVER MAIN STEM
QL,7500,7500,7500,7500,7500
XE,270,276,280,286,287,300,301,350
XC,160,240,480,520,1160,1460,1720,2450
XO
NC,,.05,,.05,,.055,,.055,,.06,,.06,,.065,,.065
XI,3.70,3.70
QN,3.70,,LOCAL INFLOW
QL,2000,2000,2000,2000,2000
XE,264,276,280,285,290,295,300,310
XC,350,350,400,2000,3300,4400,5100,5500
XO
RN,,REACH 3 DAM U/S STEEL BRK TO PLATT BROS DAM
```

```
RP,4,0,-1
RG,2,5,8,10
RC,227.4
XI,3.80,3.80,,,,,.20
QN,3.80,,INFLOW FROM STEEL BRK AND LOCAL
QL,9000,9000,9000,9000,9000
XE,256,260,268,270,275,280,290,300
XC,0,190,190,420,770,1200,1550,1850
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,4.48,4.48,,,,,.15
XE,255,257,262,270,276,280,290,300
XC,0,150,150,620,960,1200,1520,1600
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,4.84,4.84,,,,,.20
XE,254,260,268,272,280,281,290,300
XC,0,170,170,490,1290,1480,1640,1830
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,5.36,5.36,,,,,.07
XE,248,260,272,276,280,282,290,300
XC,180,180,190,240,1450,1550,1970,2470
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,5.73,5.73,,,,,.10
XE,246,260,270,275,276,290,295,300
XC,110,110,440,490,2070,2480,2590,2720
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,6.19,6.19,,,,,.10
QN,6.19,,INFLOW FROM MAD RIVER
QL,4000,4000,4000,4000,4000
XE,244,260,261,264,270,280,290,300
XC,240,240,1260,1290,1690,1920,2330,2610
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,6.63,6.63,,,,,.10
XE,235,244,252,256,260,280,290,300
XC,170,170,170,550,1140,1210,1250,1290
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,7.53,7.53,,,,,.20
XE,228,240,244,250,260,280,290,300
XC,240,240,410,850,900,1000,1240,1430
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,7.93,7.93,,,,,.20
XE,221,232,240,250,252,260,270,300
XC,190,190,260,460,480,740,920,1180
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,8.35,8.35
XE,210,220,230,240,250,260,270,300
XC,50,240,270,370,570,675,780,1100
XO
RN,,REACH 4 D/S OF PLATT BROS DAM
RP,4,0,-1
RG,2,5,8
RC,196.6
```

```
XI,8.45,8.45,,,,,.06
XE,208,210,212,215,220,223,230,235
XC,220,240,250,380,630,900,980,1630
XO
NC,.03,.04,.045,.05,.055,.06,.065,.07
XI,8.60,8.60,,,,,.05
XE,204,210,215,220,225,230,235,240
XC,200,200,350,600,850,1000,1200,1350
XO
NC,.03,.04,.045,.05,.055,.06,.065,.07
XI,8.86,8.86,,,,,.20
XE,201,204,210,215,220,225,230,240
XC,180,190,200,220,240,390,530,600
XO
NC,.03,.04,.045,.05,.055,.06,.065,.07
XI,9.10,9.10,,,,,.10
XE,197,205,210,220,225,230,235,240
XC,200,230,250,350,500,700,850,1010
XO
NC,.03,.04,.045,.05,.055,.06,.065,.07
XI,9.50,9.50,,,,,.10
XE,194,197,200,205,210,217,220,224
XC,100,320,320,320,320,320,480,500
XO
NC,.03,.04,.045,.05,.055,.06,.065,.07
XI,9.88,9.88,,,,,.20
QN,9.88,,LOCAL INFLOW FROM HOP BROOK
QL,2500,2500,2500,2500,2500
XE,187,190,200,208,209,210,215,220
XC,220,250,380,630,980,1630,1850,2600
XO
NC,.03,.04,.045,.05,.055,.06,.065,.07
XI,10.20,10.20,,,,,.05
XE,184,190,195,200,205,210,215,220
XC,150,250,300,400,550,700,950,1200
XO
NC,.03,.04,.045,.05,.055,.06,.065,.07
XI,10.45,10.45
XE,181,188,195,198,200,202,205,220
XC,100,300,420,420,530,1020,1060,1400
XO
RN,,REACH 5 D/S OF DAM D/S OF HOP BROOK
RP,4,0,-1
RG,2,4,6,9,11,14
RC,0.25
RH,80,85,91,92,93,97.1,99,101.8
RQ,0,5000,10250,22800,33800,60300,75000,108000
XI,10.55,10.55,,,,,.20
QN,10.55,,LOCAL INFLOW FROM LONGMEADOW BROOK
QL,4000,4000,4000,4000,4000
XE,178,184,190,195,200,205,210,220
XC,200,200,400,1000,1600,2200,2600,3000
XO
NC,.03,.035,.04,.045,.05,.055,.06,.065
XI,11.36,11.36,,,,,.30
XE,166,172,180,184,190,195,200,210
XC,150,300,300,310,550,730,900,1000
XO
NC,.03,.035,.04,.045,.05,.055,.06,.065
XI,12.08,12.08,,,,,.20
```

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XE,157,170,175,180,185,190,195,200
XC,120,120,700,1100,1500,1800,1900,2000
XO
NC,.025,.03,.035,.035,.04,.045,.05,.055
XI,12.57,12.57,,,,,.40
QN,12.57,,LOCAL FLOW
QL,4000,4000,4000,4000,4000
XE,148,156,160,165,170,175,180,190
XC,50,150,150,200,240,290,330,420
XO
NC,.025,.025,.03,.03,.035,.04,.045,.05
XI,13.23,13.23,,,,,.10
XE,141,150,160,165,170,180,190,200
XC,50,200,200,220,250,300,360,410
XO
NC,.035,.04,.045,.05,.055,.055,.06,.065
XI,14.00,14.00,,,,,.10
XE,130,135,140,150,160,170,180,190
XC,150,300,600,800,1050,1060,1080,1100
XO
NC,.035,.04,.045,.05,.055,.055,.06,.065
XI,14.30,14.30,,,,,.20
XE,121,130,135,140,150,155,160,170
XC,150,150,600,1100,1600,2100,3000,3200
XO
NC,.03,.03,.035,.035,.04,.045,.05,.055
XI,14.77,14.77,,,,,.30
XE,114,119,125,130,135,140,150,160
XC,180,180,180,250,400,550,680,720
XO
NC,.025,.025,.03,.03,.035,.04,.045,.05
XI,15.39,15.39,,,,,.20
XE,106,115,120,130,133,135,140,150
XC,170,170,170,170,550,680,910,1390
XO
NC,.025,.025,.03,.03,.035,.04,.045,.05
XI,15.87,15.87,,,,,.20
XE,100,108,115,120,125,130,135,140
XC,150,160,170,180,570,920,1100,1300
XO
NC,.025,.025,.03,.03,.035,.04,.045,.05
XI,16.38,16.38,,,,,.15
XE,95,100,105,110,115,120,125,130
XC,130,140,300,480,730,960,1040,1100
XO
NC,.03,.03,.035,.04,.045,.05,.055,.06
XI,17.07,17.07,,,,,.10
XE,88,90,95,100,105,110,115,120
XC,100,150,300,460,1080,1680,1870,2060
XO
NC,.03,.035,.04,.045,.05,.055,.06,.065
XI,17.45,17.45,,,,,.10
XE,85,90,100,101,105,110,115,120
XC,150,300,350,1000,1120,1240,1360,1480
XO
NC,.03,.035,.04,.045,.05,.055,.06,.065
XI,17.91,17.91
XE,80,85,90,95,100,105,110,120
XC,200,220,250,300,450,600,700,800
XO,0,0,430,550,530,450,400,400
ZZ
EOF
EOT..
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PLATE 16-4